

I claim:

1. A test apparatus providing pulsatile flow service with a blood analog for replicating aspects of the human cardiovascular system in order to certify the operability and/or reliability of a chosen sample device, such as an implantable cardiovascular assist device, with flows and conditions that give the sample device a fairly real trial of operating in the environment of the human cardiovascular system before surgical implantation in a patient; comprising:

a main circulation circuit for the blood analog comprising in series a pump providing flow in a sequence of pulses, a mock left ventricle, a mock aortic valve, a mock aorta, and a return loop that returns to the pump; and

a bypass loop to bypass the mock aortic valve, originating on the left ventricle and terminating in the aorta, affording interconnection of the sample device;

wherein the mock aorta comprises a plurality of elastic tube sections connected in series in progression of diminishing diameters, and inter-coupled by an adjustable flow restrictor(s), each elastic tube section selected for a compliance factor measuring between about a 7% to 12% expansion of the inside diameter for a 100 mm mercury step increase of inside pressure; whereby the selection over the compliance factors for the elastic tube sections as well as the adjustability of the intermediary flow restrictor(s) allows a user to tune the test apparatus for shaping various target waveforms in regards of flowrate and pressure against time as well as target forms of the peaks and drop-offs thereof in addition.

2. The test apparatus of claim 1 wherein the pump is driven to provide a mock systole phase occurring over about 35% of one pulse's cycle, followed by a relatively longer rest or mock diastole phase which stretches approximately over about the remaining 65% of the pulse cycle.

3. The test apparatus of claim 1 wherein the pump is driven to provide the sample device with about seventy milliliters of blood analog each pulse as well as is controllable to sequence variously through various modes including:

a waking rest mode corresponding to a pulse rate of about seventy beats per minute and producing a mean aortic pressure of about 100 mm of mercury;

an exercise mode corresponding to a pulse rate of about one-hundred twenty beats per minute and producing a mean aortic pressure of about 110 mm of mercury; and

a sleep mode corresponding to a pulse rate of about fifty beats per minute and producing a mean aortic pressure of about 100 mm of mercury.

4. A test apparatus providing pulsatile flows and replicating the human cardiovascular system for testing devices, comprising:

a circuit comprising in series a mock left ventricle, a mock aortic valve, a mock aorta, and a pump circulating a fluid returned from the mock aorta in pulsatile flow to the mock left ventricle; and

a loop from the mock left ventricle to the mock aorta that bypasses the mock aortic valve and affords interconnection of a test device;

wherein the mock aorta comprises elastic tube sections serially connected from a first-in-progression successively to a last-in-progression, and which are intermediately interconnected by a flow restrictor such that a pulse of fluid inputted to the first-in-progression elastic tube section causes swelling therein that thereupon is discharged through the corresponding flow restrictor into the succeeding elastic tube section, which succeeding elastic tube section correspondingly swells as a result thereof but lagging behind in time;

whereby the rippling time lag of swelling in the succeeding elastic tube sections relatively replicates the human cardiovascular system.

5. The test apparatus of claim 4 wherein the mock aorta comprises a plurality of elastic tube sections connected in series in progression of diminishing diameters.

6. The test apparatus of claim 4 wherein each flow restrictor is adjustable.

7. The test apparatus of claim 6 wherein each flow restrictor(s) comprises a valve.

8. The test apparatus of claim 4 wherein each elastic tube section is characterized by about 7% to 12% inside-diameter expansion for 100 mm mercury step increase in pressure.

9. The test apparatus of claim 4 wherein the test device comprises an implantable cardiovascular assist device whereby said test apparatus affords a fairly real trial of operating in the environment of the human cardiovascular system before surgical implantation of such device in a patient.

10. The test apparatus of claim 4 wherein the test device comprises a left ventricle assist device.

11. The test apparatus of claim 4 wherein the pump is driven to provide a mock systole phase occurring over about 35% of one pulse's cycle, followed by a relatively longer rest or mock diastole phase which stretches approximately over about the remaining 65% of the pulse cycle.

12. The test apparatus of claim 4 wherein the pump is driven to provide the test device with about seventy milliliters of fluid each pulse as well as is controllable to sequence variously through various modes including:

a waking rest mode corresponding to a pulse rate of about seventy beats per minute and producing a mean aortic pressure of about 100 mm of mercury;

an exercise mode corresponding to a pulse rate of about one-hundred twenty beats per minute and producing a mean aortic pressure of about 110 mm of mercury; and

a sleep mode corresponding to a pulse rate of about fifty beats per minute and producing a mean aortic pressure of about 100 mm of mercury.

13. A test apparatus providing pulsatile flows and replicating the human cardiovascular system pulsatile flows, comprising:

a circuit comprising in series a plenum, a check valve, a cardiovascular system, and a pump circulating a fluid returned from the cardiovascular system in pulsatile flow to the plenum;

wherein the mock cardiovascular system comprises elastic tube sections serially connected from a first-in-progression successively to a last-in-progression, and which are intermediately interconnected by a flow restrictor such that a pulse of fluid inputted to the first-in-progression elastic tube section causes swelling therein that thereupon is discharged through the corresponding flow restrictor into the succeeding elastic tube section, which succeeding elastic tube section correspondingly swells as a result thereof but lagging behind in time; whereby the rippling time lag of swelling in the succeeding elastic tube sections relatively replicates the human cardiovascular system.

14. The test apparatus of claim 13 further comprising a loop from the plenum to the mock cardiovascular system that bypasses the check valve and affords interconnection of a test device.

15. The test apparatus of claim 14 wherein the test device comprises an implantable cardiovascular assist device whereby said test apparatus affords a fairly real trial of operating in the environment of the human cardiovascular system before surgical implantation of such device in a patient.

16. The test apparatus of claim 14 wherein the test device comprises a ventricle assist device.

17. The test apparatus of claim 13 wherein the mock cardiovascular system comprises a plurality of elastic tube sections connected in series in progression of diminishing diameters.

18. The test apparatus of claim 13 wherein each flow restrictor is adjustable.

19. The test apparatus of claim 13 wherein each elastic tube section is characterized by about 7% to 12% inside-diameter expansion for 100 mm mercury step increase in pressure.

20. The test apparatus of claim 13 wherein the pump is driven to provide a mock systole phase occurring over about 35% of one pulse's cycle, followed by a relatively longer rest or mock diastole phase which stretches approximately over about the remaining 65% of the pulse cycle.

21. The test apparatus of claim 13 wherein the pump is driven to provide the test device with about seventy milliliters of fluid each pulse as well as is controllable to sequence variously through various modes including:

a waking rest mode corresponding to a pulse rate of about seventy beats per minute and producing a mean aortic pressure of about 100 mm of mercury;

an exercise mode corresponding to a pulse rate of about one-hundred twenty beats per minute and producing a mean aortic pressure of about 110 mm of mercury; and

a sleep mode corresponding to a pulse rate of about fifty beats per minute and producing a mean aortic pressure of about 100 mm of mercury.